

Aquatic Macrophyte Survey of the St. Croix/Gordon Flowage Douglas County, Wisconsin

JANUARY 2008



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The St. Croix/Gordon Flowage aquatic macrophyte study and report were the result of a cooperative effort between the Gordon/St. Croix Flowage Association, and University of Wisconsin Stevens Point (UWSP). Thank you all for the collaboration and direction provided. Special thanks to:

- Student Associates at the Center for Watershed Science and Education (CWSE) for assistance with sample collection.
- Lorna & Roger Wilson and Steve & Esther Alf for their assistance in data collection and outstanding hospitality.
- Brian Olson for his assistance in data collection.
- The Lookout Restaurant, ICO (Inter City Oil), and the Trading Post.
- Tuverson's and Wedge's Resorts for their accommodations of workers during the survey.
- Dave Beigel for the use of his boat during the survey.
- Dr. Robert Freckmann, Dr. Emmet Judziewicz, and Darrin Hoverson for aid in plant identification.

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INTRODUCTION

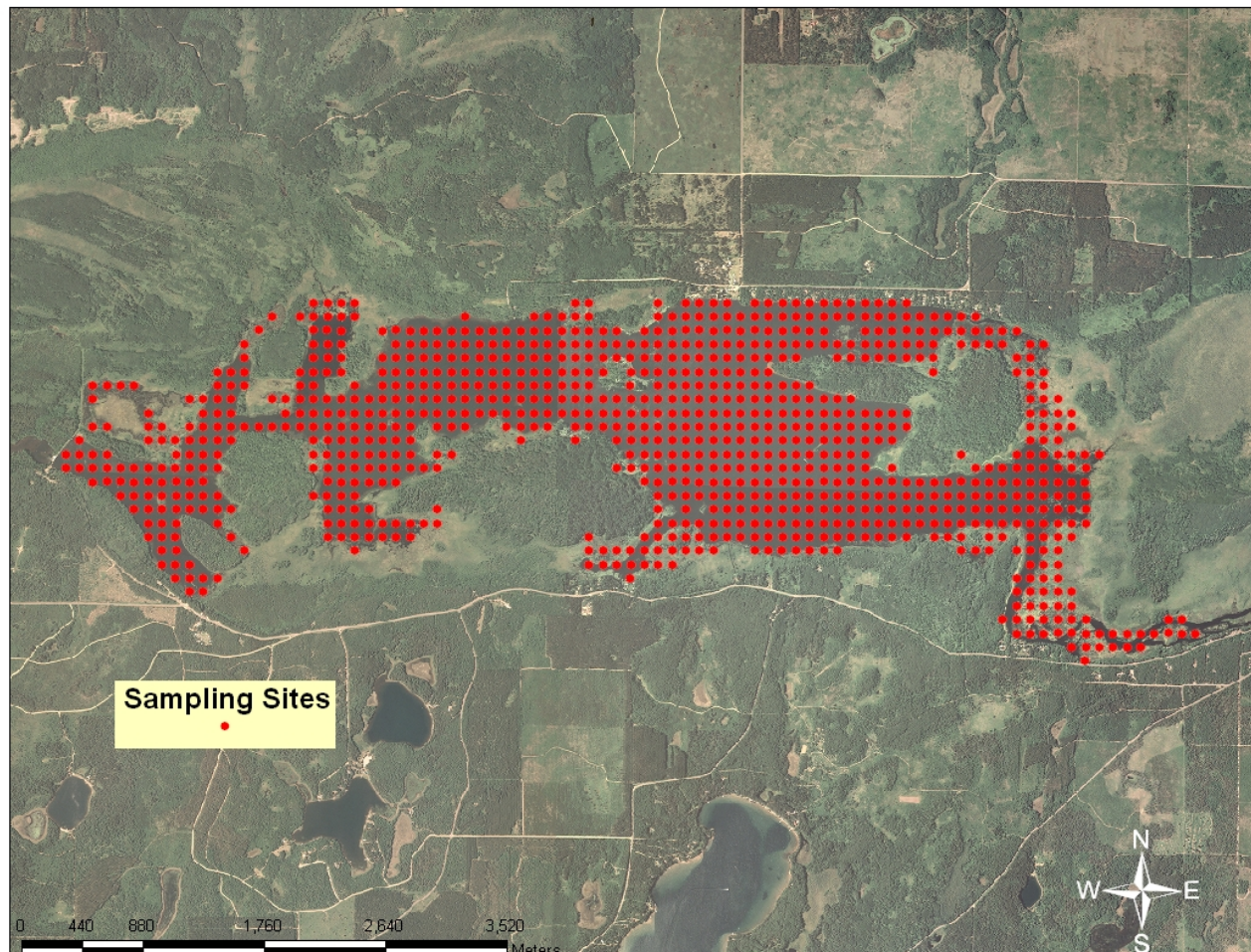
A survey of aquatic plants was conducted in the St. Croix/Gordon Flowage during the summer of 2007. The information in the survey was obtained to evaluate the aquatic plant community and can be used as baseline information or in the development of an aquatic plant management plan. The St. Croix/Gordon Flowage is a 1,913 acre impoundment of the St. Croix River. It is located just west of Gordon in Douglas County. Just below this impoundment is the beginning of the St. Croix National Scenic Riverway.

Aquatic plants play a significant role in a reservoir's ecosystem. They provide habitat for the fishery and other aquatic organisms, stabilize the sediment, reduce erosion, buffer temperature changes and waves, infuse oxygen into the water, and utilize nutrients that may otherwise be used by algae. The species of plants that comprise an aquatic plant community can provide insight into the health of the aquatic ecosystem. Some species are present only in specific conditions and may not be tolerant of disturbance, whereas, other species are very tolerant of such disturbances. Abundant growth of invasive aquatic plant species (such as Eurasian water milfoil and curly-leaf pondweed) can significantly alter the aquatic plant and fish communities in a lake. In Wisconsin the spread of these species is occurring at an alarming rate as they are transported from lake to lake by boats, trailers, and fishing equipment.

METHODS

The aquatic plant survey in the St. Croix/Gordon Flowage was conducted by UW-Stevens Point from July 30-August 3, and August 6-7. The survey was accomplished using the Wisconsin Department of Natural Resources (WDNR) point intercept sampling protocol. The GPS coordinates for the grid which consisted of 894 sites was provided by the WDNR (Figure 1). The grid was laid out with equal spacing between all points; to ensure future replication and thorough coverage of the flowage. The shape of the lake and the size of the littoral zone are the two factors used to determine the number of points and their spacing. The GPS points were uploaded onto an aerial photograph that was used in the field. A handheld GPS unit was also used to locate sampling sites while in the field.

Figure 1. Survey points for aquatic macrophyte survey using the Wisconsin DNR point intercept method.



A pole mounted rake was used to collect an aquatic plant sample at each accessible site. The rake had a double rake head with fourteen teeth on each side with a width of 13.8 inches. After the rake was brought up each species present was assigned a fullness rating. Ratings ranged from 0 (plants not present) to 3 (plants overflowing the rake tines). At each site depth and dominant sediment type were also recorded.

A boat with three survey members was used during the St. Croix/Gordon Flowage survey. Volunteers drove the boats while staff from the UWSP CWSE raked, identified, and recorded aquatic plants. There were a number of points that were inaccessible by boat. If the water was too shallow for the boats kayaks were used to access as many of the points as possible. The rake method was unusable while working from a kayak; because of this only visual observations were made at these sites. Even with kayaks 150 of the sites were not accessible.

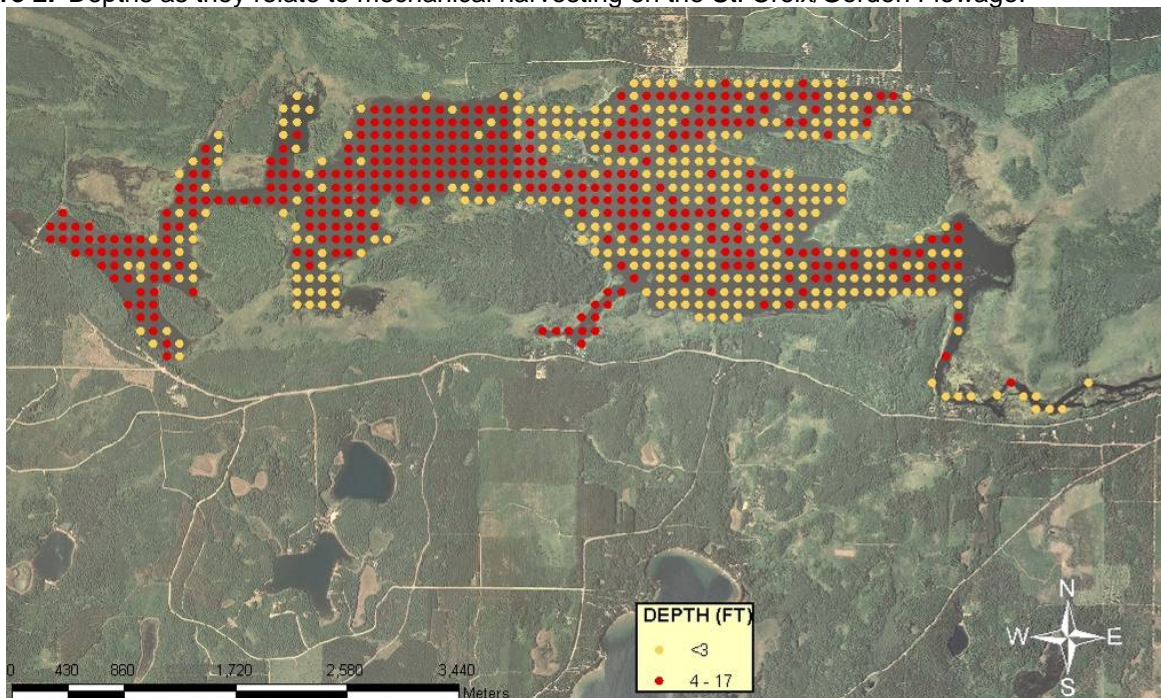
Two invasive plants species currently exist in the St. Croix/Gordon Flowage. Eurasian water milfoil, EWM (*Myriophyllum spicatum*) and curly-leaf pondweed, CLP (*Potamogeton crispus*) exist in relatively small numbers near the west end of the flowage. The CLP has been around for at least two years while the Eurasian water milfoil was just discovered in small quantities near the boat landing in July 2007. Because CLP matures, produces turions, and dies off in late June the CLP was surveyed by volunteers in June 2007 using air photos and a handheld GPS units to record the location of CLP beds.

RESULTS & DISCUSSION

The survey was based on 894 sites that were assigned using the WDNR's point-intercept protocol; 744 of these points were accessible to sample during this survey. Ninety-three percent (691) of the 744 sites had vegetative growth. The points that were not surveyed were inaccessible by boat or kayak; causes included water too shallow, the points were placed on land, or the points were in water which was landlocked. Twenty-nine sites were sampled using the kayaks.

The deepest depth at which aquatic plant growth was found was 17.1 ft. In the St. Croix/Gordon Flowage aquatic plants are capable of growing this deep due to the exceptional level of water clarity; plant growth at such depths is uncommon in many flowages in Wisconsin. Few areas in the Flowage are deeper than 17 feet and, therefore, aquatic plants can grow throughout most of the flowage. The St. Croix/Gordon Flowage is a relatively shallow body of water. Forty-seven percent of the sites sampled had a depth of 3 feet or less; the majority of these sites occur in the eastern portion of the flowage where many of the flowage's residents live (Figure 2).

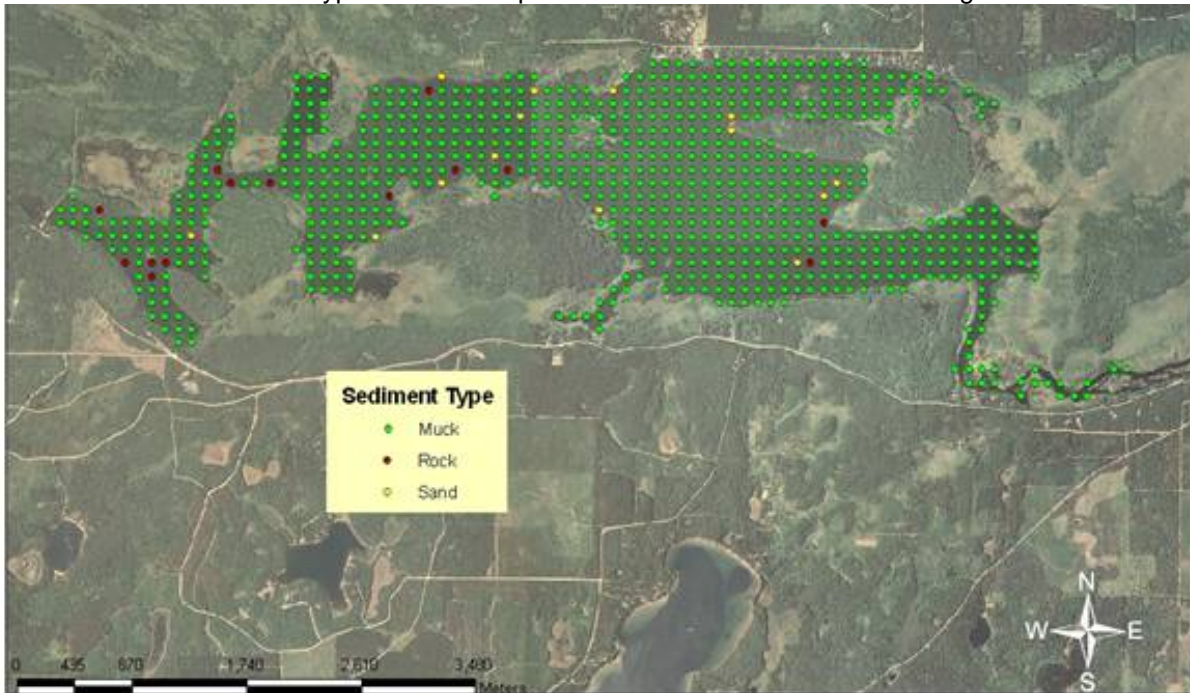
Figure 2. Depths as they relate to mechanical harvesting on the St. Croix/Gordon Flowage.



Dominant sediment type was assessed at each site. Using the DNR protocol for aquatic plant surveys the categories of sand, muck, or rock were given for dominant sediment type; only one classification was allowed per site. Muck was the dominant sediment type throughout the flowage; 96% of the sites had

mucky bottoms. Of the remaining sites, 2% consisted of sand and 2% of the sites had sediment predominantly composed of rocks (Figure 3).

Figure 3. Dominant sediment type at each sample site in the St. Croix/Gordon Flowage.



Fifty-eight aquatic plant species were collected and identified in the survey conducted in July/August 2007. This is much higher than the number of species found in eight northern flowages sampled in 1994 where only thirty-seven species of aquatic plants were identified. The survey in 1994 consisted of approximately 320 sites, which is less than half of the number of sites in the 2007 survey. This may account for the difference in the number of species that were identified. A difference in sampling technique may also account for some of this variance. The 2007 survey employed the point-intercept method that was recently adopted by WDNR as recommended methodology, the 1994 survey used the previous WDNR transect method. This involved sampling approximately 80 transects and within each transect four points were selected at varying depths: 0-0.5m, 0.5-1.5m, 1.5-2.5, and the last point at a depth deeper than 2.5m (Weber, et al. 1994). A list of aquatic plant species from both surveys is shown in

Table 1.

Table 1. Aquatic plant species identified in 1994 and 2007 surveys in the St. Croix/Gordon Flowage.

Genus\species	Common Name	1994	2007
<i>Alisma trivale</i>	Northern water plantain		x
<i>Asclepias incarnata</i>	Swamp milkweed		x
<i>Bidens beckii</i>	Water marigold	x	x
<i>Brasenia schreberi</i>	Watersheild	x	x
<i>Calla palustris</i>	Wild calla	x	x
<i>Carex camosa</i>	Bristly sedge	x	
<i>Carex sp</i>	Sedges	x	
<i>Ceratophyllum demersum</i>	Coontail	x	x
<i>Ceratophyllum echinatum</i>	Spiny hornwort		x
<i>Chara spp.</i>	muskgrass	x	x
<i>Cicuta bubifera</i>	Water hemlock		x
<i>Drepanocladus fluitans</i>	water moss	x	
<i>Dulichium arundinaceum</i>	Three way sedge		x
<i>Eleocharis acicularis</i>	Needle spikerush		x
<i>Eleocharis palustris</i>	Creeping spikerush	x	x
<i>Elodea Canadensis</i>	Common waterweed	x	x
<i>Elodea Nuttallii</i>	Slender waterweed		x
<i>Equisetum fluviatile</i>	Water horsetail		x
<i>Filamenouts Algae</i>			x
<i>Iris versicolor</i>	Northern blue flag	x	x
<i>Lemna minor</i>	Small duckweed	x	
<i>Lemna trisulca</i>	Forked duckweed	x	x
<i>Lemna turionifera</i>	Turion duckweed		x
<i>Myosotis scorpioides</i>	Common forget-me-not		x
<i>Myriophyllum sibiricum</i>	Northern water milfoil	x	x
<i>Myriophyllum spicatum</i>	Eurasian water milfoil		x
<i>Najas flexilis</i>	Slender naiad	x	x
<i>Najas gracillima</i>	Northern naiad		x
<i>Nitella sp</i>	Stoneworts	x	
<i>Nuphar variegata</i>	Spatterdock	x	x
<i>Nymphaea tuberosa (odorata)</i>	White water lily	x	x
<i>Polygonum amphibium</i>	Water smartweed		x
<i>Potamogeton amplifolius</i>	Large-leaf pondweed	x	x
<i>Potamogeton berchtoldii (pusillus)</i>	Small pondweed	x	x
<i>Potamogeton crispus</i>	Curly-leaf pondweed		x
<i>Potamogeton gramineus</i>	Variable pondweed	x	x
<i>Potamogeton illinoensis</i>	Illinois pondweed		x
<i>Potamogeton natans</i>	Floating-leaf pondweed	x	x
<i>Potamogeton praelongus</i>	White-stem pondweed		x
<i>Potamogeton richardsonii</i>	Clasping-leaf pondweed	x	x
<i>Potamogeton robbinsii</i>	Fern-leaf pondweed	x	x
<i>Potamogeton zosteriformes</i>	Flat-stem pondweed	x	x
<i>Potentilla palustris</i>	Marsh cinquefoil	x	x
<i>Potamogeton pectinataus</i>	Sago pondweed	x	x
<i>Ranunculus longirostris</i>	Stiff water crowfoot		x
<i>Rorippa nasturtium-aquaticum</i>	Water cress		x
<i>Sagittaria cristata</i>	Crested arrowhead		x
<i>Sagittaria cuneata</i>	Arum-leaved arrowhead	x	
<i>Sagittaria graminea</i>	Grass-leaved arrowhead		x

Table 1 continued.			
Genus\species	Common Name	1994	2007
<i>Sagittaria spp</i>	Arrowhead		x
<i>Schoenoplectus subterminalis</i>	Water bulrush	x	x
<i>Schoenoplectus validus</i>	Softstem bulrush	x	x
<i>Sparganium chlorocarpum</i>	Short-stemmed bur-reed	x	
<i>Sparganium emersum</i>	Softstem bur-reed		x
<i>Sparganium Eurycarpum</i>	Common bur-reed	x	x
<i>Sparganium fluctans</i>	Floating leaved bur-reed		x
<i>Spirodela polyrhiza</i>	Great duckweed		x
<i>Typha latifolia</i>	Broad-leaved cattail		x
<i>Utricularia intermedia</i>	Flat-leaf bladderwort	x	x
<i>Utricularia minor</i>	Small bladderwort		x
<i>Utricularia vulgaris</i>	Common bladderwort	x	x
<i>Vallisneria americana</i>	Wild celery	x	x
<i>Zizania palustris</i>	Wild rice		x
<i>Zosterella dubia</i>	Water star grass	x	x

Table 2. Statistics for the 1994 aquatic plant survey in St. Croix/Gordon Flowage.

Genus\species	Common Name	Frequency	Relative Frequency	Average Density
<i>Bidens beckii</i>	Water marigold	17.9	5	2
<i>Brasenia schreberi</i>	Watersheid	12	3.3	2.3
<i>Calla palustris</i>	Wild calla	Not found at transects		
<i>Carex camosa</i>	Bristly sedge	0.6	0.2	1.5
<i>Carex sp</i>	Sedges	1.9	0.5	2.3
<i>Ceratophyllum demersum</i>	Coontail	38.9	10.8	2.6
<i>Chara sp</i>	muskgrass	0.6	0.2	1
<i>Drepanocladus fluitans</i>	water moss	4.5	1.2	2.3
<i>Eleocharis palustris</i>	Common spikerush	0.6	0.2	1.5
<i>Elodea canadensis</i>	Common waterweed	40.8	11.3	2.4
<i>Iris versicolor</i>	Northern blue flag	Not found at transects		
<i>Lemna minor</i>	Small duckweed	3.4	0.9	2.3
<i>Lemna trisulca</i>	Forked duckweed	10.7	3	1.9
<i>Myriophyllum sibiricum</i>	Northern water milfoil	16.5	4.6	1.9
<i>Najas flexilis</i>	Slender naiad	7.7	2.1	2.6
<i>Nitella sp</i>	Stoneworts	1.9	0.5	1.1
No vegetation		3.2	0.9	2.5
<i>Nuphar variegatum</i>	Spatterdock	9.2	2.6	2.3
<i>Nymphaea tuberosa</i> (odorata)	White water lily	20.1	5.6	2.8
<i>Potamogeton amplifolius</i>	Large-leaf pondweed	22.6	6.3	1.7
<i>Potamogeton berchtoldii</i> (pusillus)	Small pondweed	12.8	3.6	2
<i>Potamogeton gramineus</i>	Variable pondweed	0.9	0.2	4
<i>Potamogeton natans</i>	Floating-leaf pondweed	1.5	0.4	2.3
<i>Potamogeton pectinatus</i>	Sago pondweed	1.1	0.3	1.7
<i>Potamogeton richardsonii</i>	Clasping-leaf pondweed	11.8	3.3	1.5
<i>Potamogeton robbinsii</i>	Fern-leaf pondweed	61.3	17	3.3
<i>Potamogeton zosteriiformes</i>	Flat-stem pondweed	27.4	7.6	2.1
<i>Potentilla palustris</i>	Marsh cinquefoil	Not found at transects		

Table 2 (cont.)				
Genus\species	Common Name	Frequency	Relative Frequency	Average Density
<i>Sagittaria cuneata</i>	Arum-leaved arrowhead	0.9	0.2	2
<i>Sagittaria latifolia</i>	Common arrowhead	0.2	0.1	1
<i>Scirpus subterminalis</i>	Water bulrush	0.9	0.2	1.3
<i>Scirpus validus</i>	Softstem bulrush	0.4	0.1	2
<i>Sparganium chlorocarpum</i>	Short-stemmed bur-reed	1.9	0.5	1.3
<i>Sparganium eurycarpum</i>	Common bur-reed	Not found at transects		
<i>Utricularia intermedia</i>	Flat-leaf bladderwort	0.4	0.1	2
<i>Utricularia vulgaris</i>	Common bladderwort	5.6	1.5	2.2
<i>Vallisneria americana</i>	Wild celery	19	5.3	2.1
<i>Zosterella dubia</i>	Water star grass	1.1	0.3	1

Frequency of Occurrence

The frequency of occurrence (FO) value is a measure of the percent of the points sampled that had vegetation. For St Croix/Gordon Flowage the FO was 92.9%. The FO value is very high compared to many Northern Wisconsin flowages. This is likely due to the shallow water depths and good water clarity in this flowage.

The most common aquatic plant species found in the St. Croix/Gordon Flowage was fern-leaved pondweed (*Potamogeton robbinsii*). Fern-leaved pondweed occurred at 68% of the sites. The second most abundant aquatic plant species was Coontail (*Ceratophyllum demersum*) which occurred at approximately 60% of the sites. All species which occurred at more than 10% of the sites in the flowage are displayed in

Figure 4.

Although northern water milfoil, NWM (*Myriophyllum sibiricum*) had the fifth highest frequency of occurrence it is one of the more noticeable species on the flowage. NWM can demonstrate growth patterns similar to its invasive counterpart Eurasian water milfoil (EWM), however it does not usually spread as rapidly as EWM. In the central portion of the impoundment there are aquatic plant beds which are comprised almost entirely of NWM. In these same locations NWM grows to the surface and may be considered a recreational nuisance (Figure 5).

Figure 4. Frequency of occurrence for aquatic plant species (found at >10% of the sites) in St. Croix/Gordon Flowage.

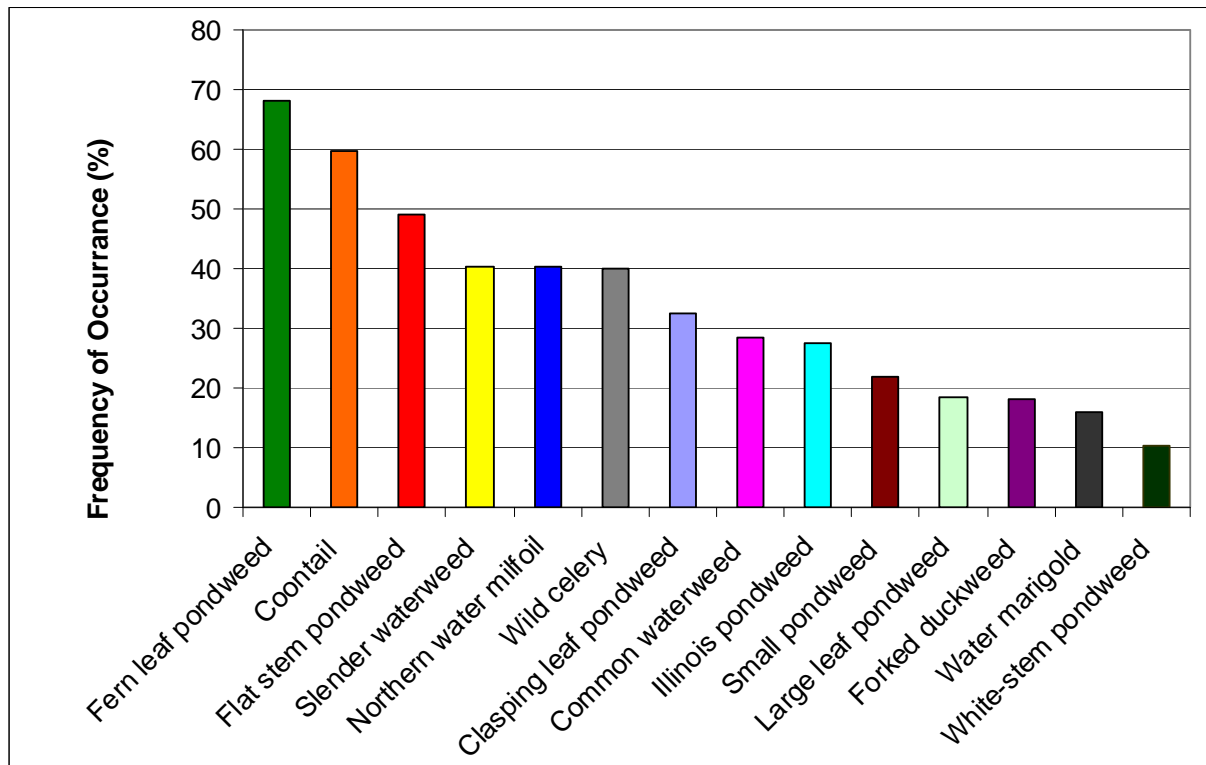
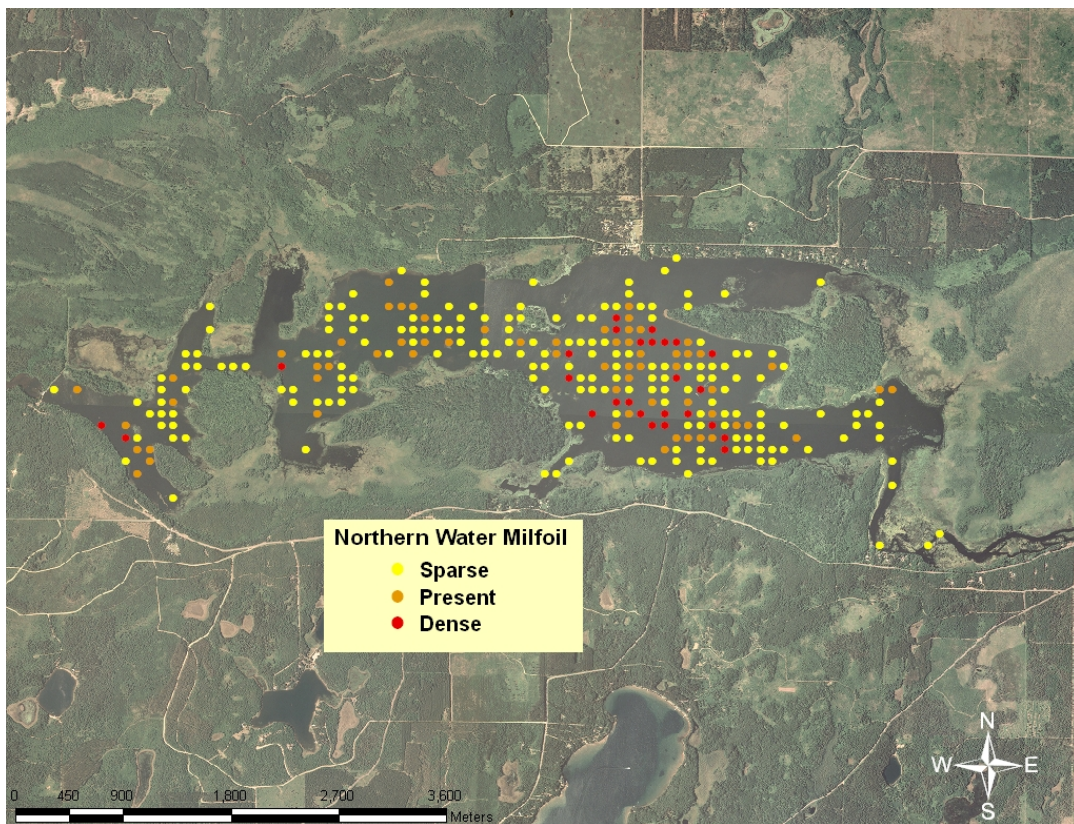


Figure 5. Location and density of northern water milfoil in the St. Croix/Gordon Flowage.



SIMPSON DIVERSITY INDEX

The Simpson Diversity Index (SDI) quantifies biodiversity based on a formula that uses the number of species surveyed and the number of individuals per site. The SDI uses a decimal scale; values closer to one represent higher amounts of biodiversity. The SDI of the flowage for the 2007 survey was 0.92. This is the same value found in the 1994 survey. The St. Croix/Gordon Flowage ranked number one out of nine northern Wisconsin flowages surveyed at that time (Table 3).

Table 3. Species diversity index of some northern Wisconsin reservoirs (Weber, 1999).

Reservoir	SDI
St. Croix	.92
Willow*	.90
Caldron Falls	.90
Spirit Reservoir*	.89
Minong	.87
Wissota	.82
Brule	.69
Rainbow*	.67
Gile*	.39
Big Eau Pleine*	.02
* reservoir is subject to fluctuating water levels	

FLORISTIC QUALITY INDEX

The Floristic Quality Index (FQI) evaluates the closeness of a plant community to undisturbed conditions. Each plant is assigned a coefficient of conservatism (C value) that reflects its sensitivity to disturbance and these numbers are used to calculate the FQI. C values range from 0 to 10, the higher the number, the more intolerant of disturbance. A zero C value is assigned to exotic and most nonvascular species, and therefore these species are not included in the calculation. The FQI for the St. Croix/Gordon Flowage was 38.4; this is higher than the median FQI for statewide lakes and reservoirs and northern lakes and forest flowages (NLFF) (Table 4). The median FQI and median average c value for St. Croix/Gordon Flowage are above the statewide values for flowages.

Table 4. Median floristic quality indices for St. Croix/Gordon Flowage, statewide, and Northern Lakes Forest Flowages.

	Median species #	Median average C value	Median FQI
St. Croix/Gordon Flowage	41	6.1	38.4
Statewide	13	6.0	22.2
NLFF	23.5	6.2	28.3

Nichols, et al. 1998

In St. Croix/Gordon Flowage the c value ranged from 1 to 10 (Table 5). The only invasive species sampled was *Potamogeton crispus*, or curly-leaf pondweed, which has a c value of 0. Spiny hornwort, floating bur-reed, and small bladderwort all have c values of 10 (Table 5). Thirty percent of the species found in St. Croix/Gordon Flowage had a c value of 8 or greater indicating the good health of the aquatic plant community. The species with the highest frequency of occurrence was fern-leaf pondweed; it has a c value of 8. Figure 4 shows the highest c value at each sampling site. Many of the sites have a c value of 8 which in many cases is associated with the fern leaf pondweed. Fern-leaf pondweed is an indicator of a healthy aquatic ecosystem and is present in much of the St. Croix/Gordon Flowage.

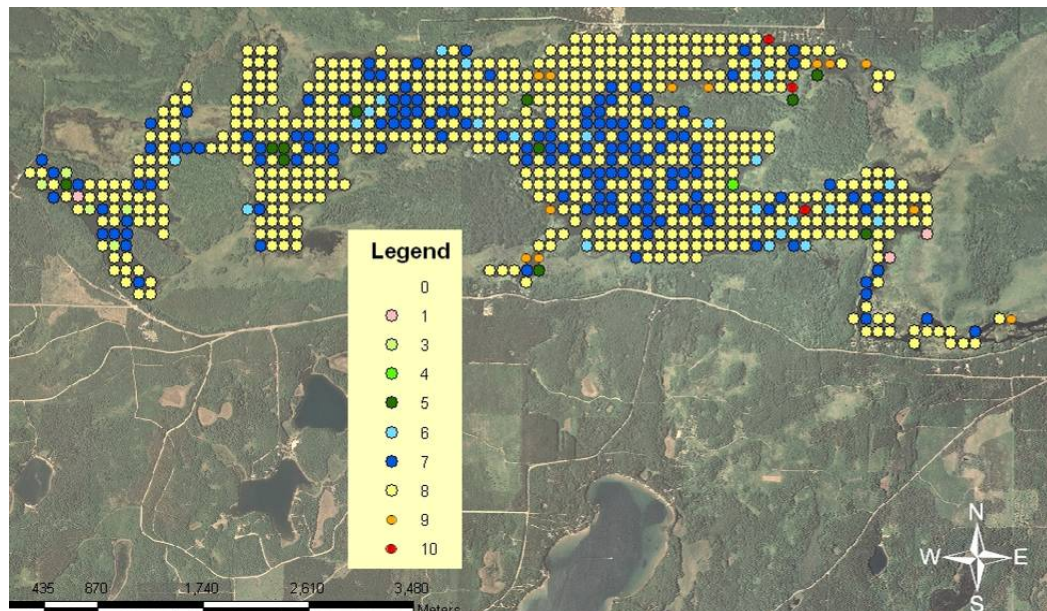
Table 5. Coefficient of Conservatism values for species present in the St. Croix/Gordon Flowage.

Scientific Name	Common Name	Coefficient of Conservatism (c)
<i>Ceratophyllum echinatum*</i>	Spiny hornwort	10
<i>Sparganium fluctuans</i>	Floating leaved bur-reed	10
<i>Utricularia minor</i>	Small bladderwort	10
<i>Calla Palustris</i>	Wild calla, water arum	9
<i>Dulichium arundinaceum</i>	Three-way sedge	9
<i>Sagittaria graminea</i>	Grass-leaved arrowhead	9
<i>Schoenoplectus subterminalis</i>	Water bulrush	9
<i>Sparganium emersum</i>	Softstem bur-reed	9
<i>Utricularia intermedia</i>	Flat-leaf bladderwort	9
<i>Bidens Beckii</i>	Water marigold	8
<i>Potamogeton praelongus</i>	White-stem pondweed	8
<i>Potamogeton Robbinsii</i>	Fern-leaf pondweed	8
<i>Potentilla palustris</i>	Marsh cinquefoil	8
<i>Sagittaria cristata</i>	Crested arrow-head	8
<i>Sagittaria rigida</i>	Stiff arrow-head	8
<i>Sagittaria spp.</i>	Arrow-head	8
<i>Zizania palustris</i>	Wild rice	8
<i>Brasenia schreberi</i>	Watersheild	7
<i>Chara sp.</i>	Muskgrass	7
<i>Cicuta bulbifera</i>	Bulb bearing water hemlock	7
<i>Elodea Nuttallii</i>	Slender waterweed	7
<i>Equisetum fluviatile</i>	Water horsetail	7
<i>Myriophyllum sibiricum</i>	Northern water milfoil	7
<i>Najas gracillima</i>	Northern naiad	7
<i>Potamogeton amplifolius</i>	Large-leaf pondweed	7
<i>Potamogeton gramineus</i>	Variable pondweed	7
<i>Potamogeton pusillus</i>	Small pondweed	7
<i>Utricularia vulgaris</i>	Common bladderwort	7
<i>Eleocharis palustris</i>	Creeping Spikerush	6
<i>Eleocharis palustris</i>	Common spikerush	6

Scientific Name	Common Name	Coefficient of Conservatism
<i>Lemna trisulca</i>	Forked duckweed	6
<i>Najas flexilis</i>	Slender naiad	6
<i>Nuphar variegata</i>	Spatterdock	6
<i>Nymphaea odorata</i>	White water lily	6
<i>Potamogeton illinoensis</i>	Illinois pondweed	6
<i>Potamogeton zosteriformis</i>	Flat-stem pondweed	6
<i>Ranunculus longirostris</i>	Stiff water crowfoot	6
<i>Vallisneria americana</i>	Wild celery	6
<i>Zosterella dubia</i>	Water star grass	6
<i>Asclepias incarnata</i>	Swamp milkweed	5
<i>Iris versicolor</i>	Northern blue flag	5
<i>Lemna turionifera</i>	Turion duckweed	5
<i>Potamogeton natans</i>	Floating-leaf pondweed	5
<i>Potamogeton richardsonii</i>	Clasping-leaf pondweed	5
<i>Sparganium Eurycarpum</i>	Common bur-reed	5
<i>Spirodela polyrhiza</i>	Great duckweed	5
<i>Schoenoplectus validus</i>	Softstem Bulrush	4
<i>Scirpus validus</i>	Softstem bulrush	4
<i>Ceratophyllum demersum</i>	Coontail	3
<i>Eleocharis acicularis</i>	Needle spikerush	3
<i>Elodea canadensis</i>	Common waterweed	3
<i>Potamogeton pectinatus</i>	Sago pondweed	3
<i>Typha latifolia</i>	Broad-leaved cattail	1
<i>Myosotis scorpioides</i>	common forget-me-not	0
<i>Potamogeton crispus</i>	Curly-leaf pondweed	0
<i>Rorippa nasturtium-aquaticum</i>	Water cress	0

**Species of special concern*

Figure 6. Maximum Coefficient of Conservatism value found at each sample site in the St. Croix/Gordon Flowage.

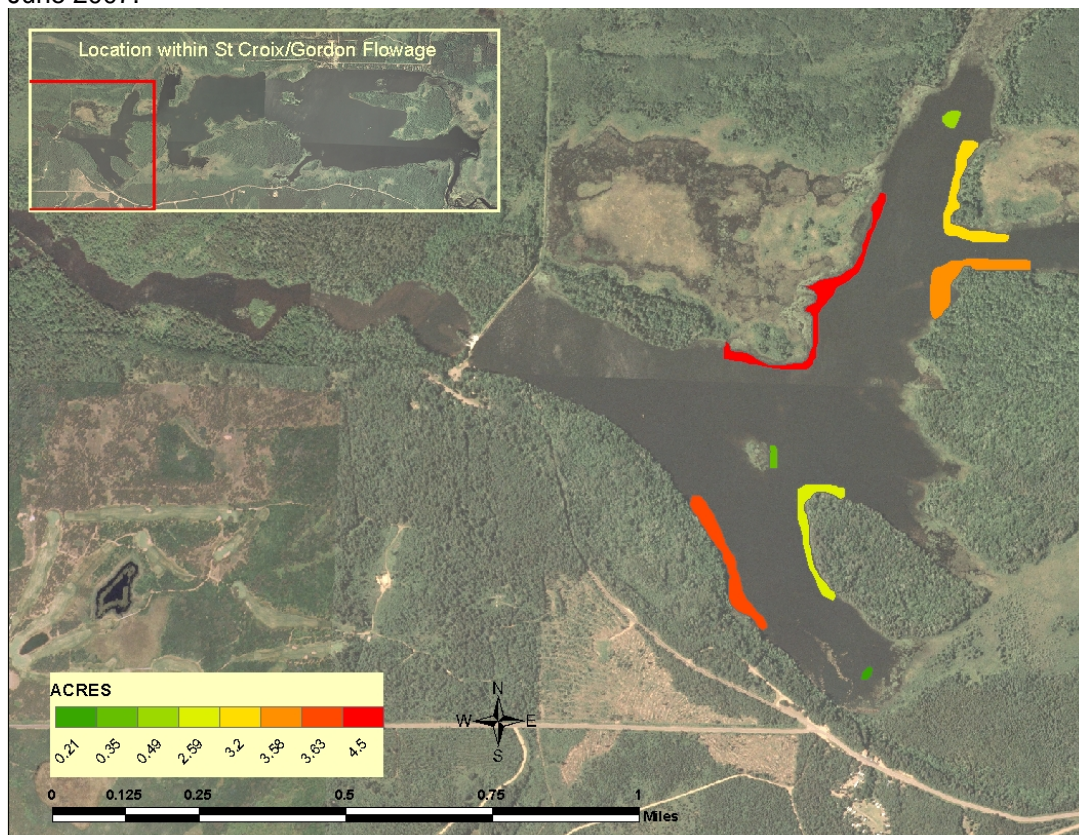


AQUATIC INVASIVE SPECIES

Invasive species have yet to become a major problem in the flowage. EWM has been identified and preliminary steps to control it were taken by the lake association in fall 2007. In June of 2007 a survey was conducted to locate and identify beds of Curly-leaf pondweed. The survey was conducted in June due to the unique life cycle of the plant. Curly-leaf pondweed dies off in late June, releasing phosphorus from their plant tissue into the water. The timing of this can be problematic by fueling filamentous and other algae growth for the balance of the summer. The CLP turions, or winter buds, establish themselves in a suitable substrate shortly after die back. When conditions are right the plant will begin growing later in the summer and into the fall. It resumes growth shortly after ice out; this unique life cycle gives it a head start and a competitive advantage over other aquatic plants. New growth of CLP was sampled during the July/August survey near some of these locations.

The survey found numerous beds which were all located in the western end of the flowage (Figure 7). Beds ranged from 0.2 to 4.5 acres, totaling 18.5 acres. Phosphorus release to the water from these stands during die off depends upon the density. Estimates range from 0.05 kg (low density) to 0.58 kg (dense). At a minimum these stands should be monitored and action to control additional spread should be considered.

Figure 7. Location of curly-leaf pondweed beds in the western portion of the St. Croix/Gordon Flowage, June 2007.



CONCLUSIONS

St. Croix/Gordon Flowage has a large and highly diverse aquatic plant community. The management of the flowage does not involve severe water level fluctuations which allows for more stable conditions for aquatic plants and in some cases may increase the possibility for the presence of rare species that may be less tolerant of disturbance.

Aquatic plant growth is abundant in the flowage due to the shallow depth of water and rich sediments delivered from the St Croix River watershed. Several areas in the flowage have an abundance of northern milfoil (*Myriophyllum sibiricum*), which may be perceived as a recreational nuisance. If this abundant growth restricts adjacent property owners from accessing the open water in the flowage, management designed to provide access to the open water should be considered.

In June, curly-leaf pondweed (*Potamogeton crispus*) comprises more than 18 acres of the western part of the flowage. This plant can become invasive and problematic by releasing nutrients into the warmer June water resulting in nuisance algae blooms throughout the summer. CLP should be monitored annually in June, and if the beds continue to expand management should be considered. CLP is also abundant in the St Croix River upstream of the flowage; with this constant source of new turions it is unlikely CLP will ever be eliminated from the flowage.

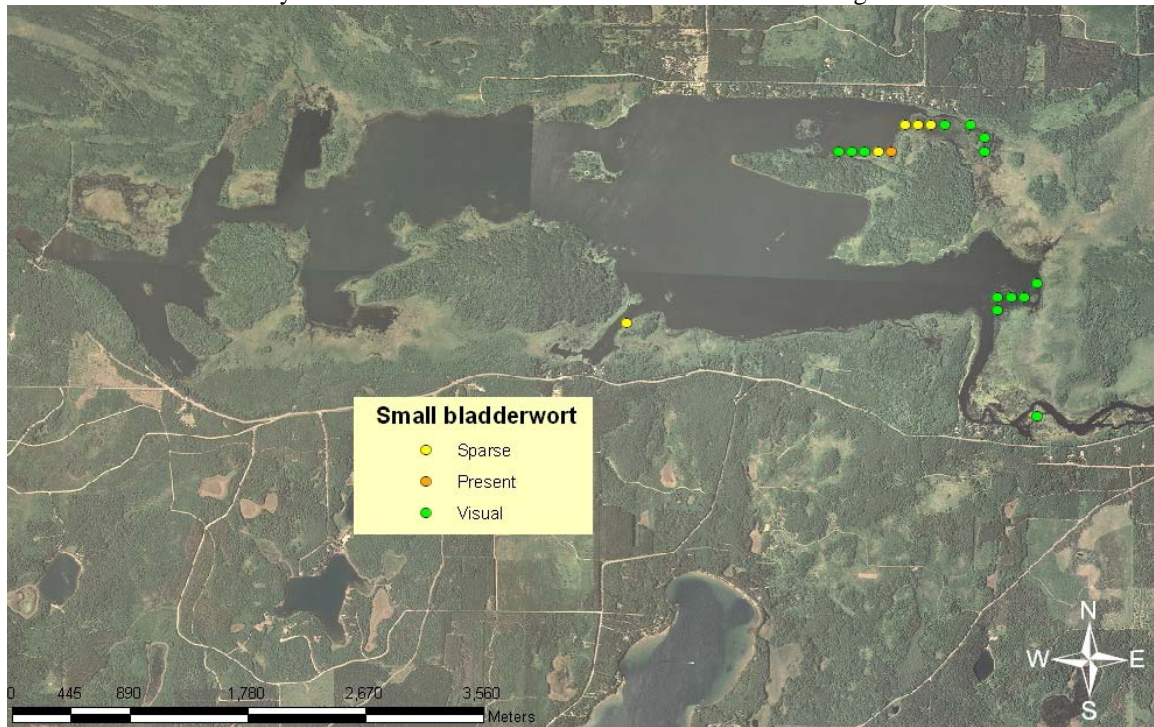
Boats and trailers that have visited other lakes can be a primary vector for the transport of aquatic invasive species therefore continued activities at the boat landing by volunteers through the Clean Boats/Clean Waters program is essential. Although the lack of intensive high speed recreational boating helps to preserve the integrity of this water body by reducing the introduction and mobilization of aquatic invasive species, the flowage is situated downstream from both natural and man made lakes. This increases the chances for aquatic invasive species to enter the flowage with its inflowing water. Surveillance for infestation of aquatic invasive species should be conducted routinely throughout the flowage by either trained citizen volunteers or paid personnel.

Aquatic plants play a critical role in the aquatic ecosystem by providing quality habitat and food for fish, invertebrates, birds, and mammals. The plants tie up nutrients which may otherwise be available to algae. Any management activities should be planned to minimize disturbance of the native species and maintain the balance between aquatic plants and algae. In addition, care should be taken to minimize the amount of denuded lake bed as these open spaces provide ideal conditions for aquatic invasive species to become established.

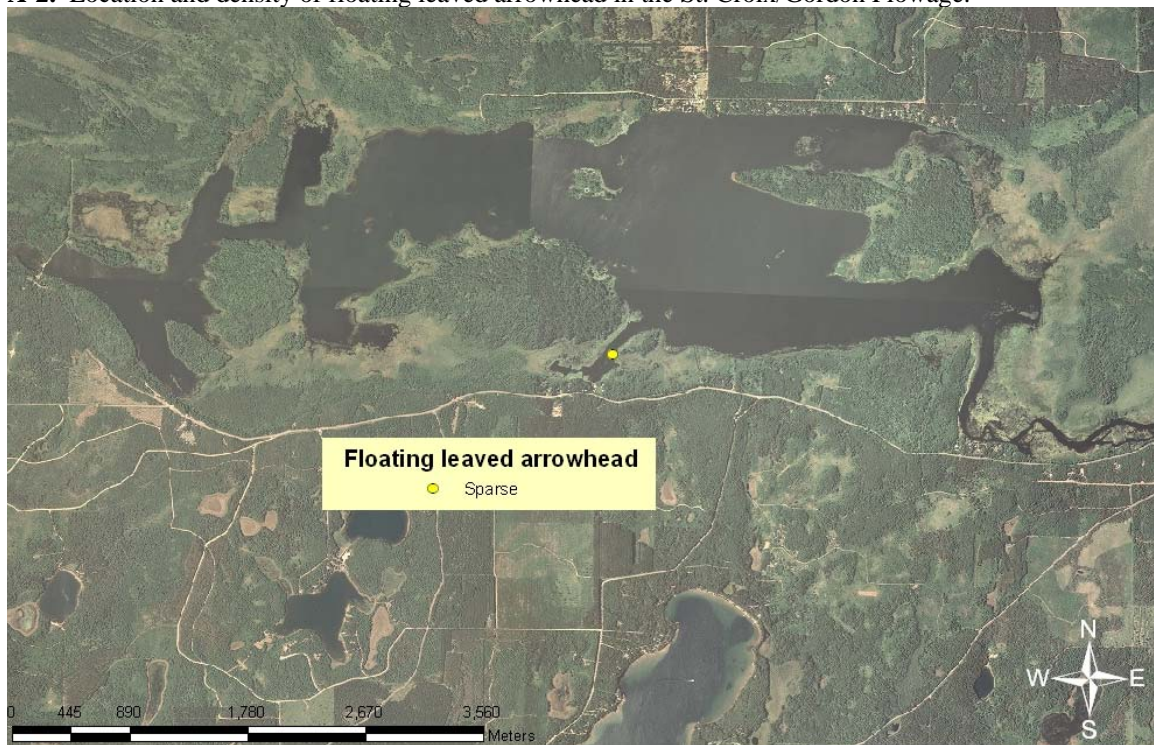
Sediment and nutrients accelerate algae and aquatic plant growth in the flowage. Sediments and nutrients occur naturally in the watershed but can be increased by disturbing near shore land and/or applying agricultural/lawn/garden fertilizer. Protection of the near shore regions in the St. Croix/Gordon Flowage and throughout the watershed will help to reduce the amount of sediment and phosphorus delivered to the flowage. A minimum distance of 35 feet from the water's edge onto shore should have a vegetative buffer in place to provide sufficient filtering of runoff. Healthy vegetated shoreland buffers are comprised of grasses/forbs, shrubs, and trees.

APPENDIX

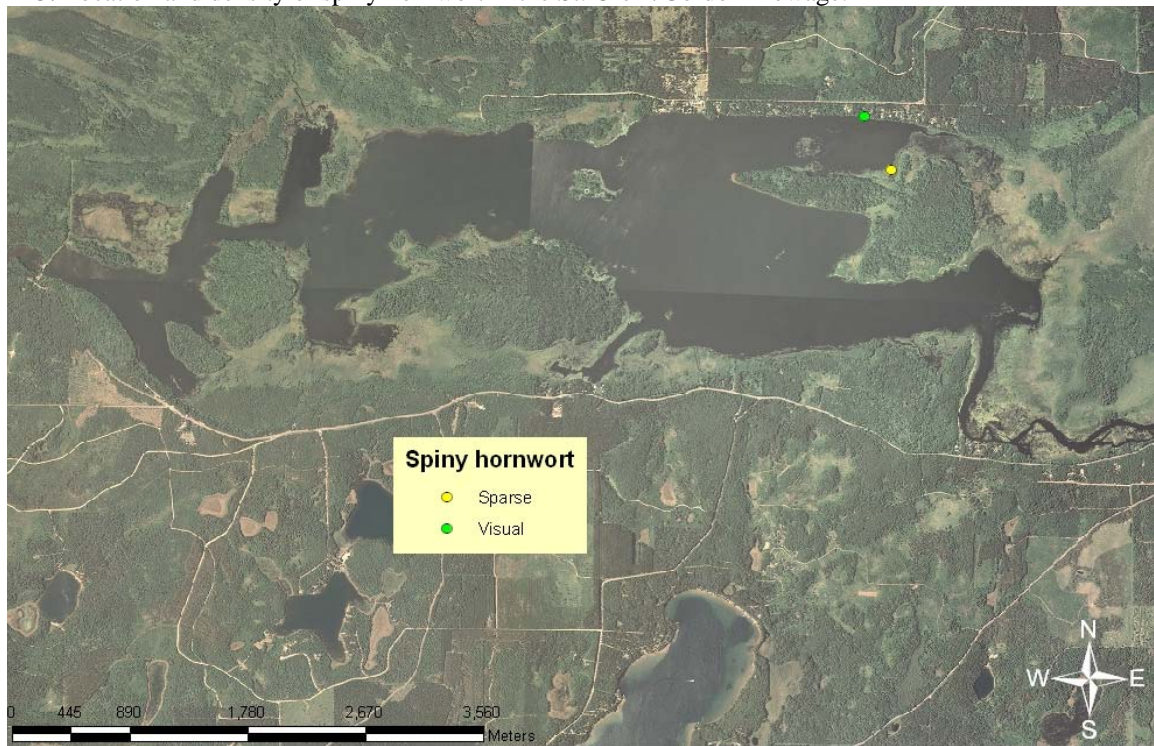
A-1. Location and density of small bladderwort in the St. Croix/Gordon Flowage.



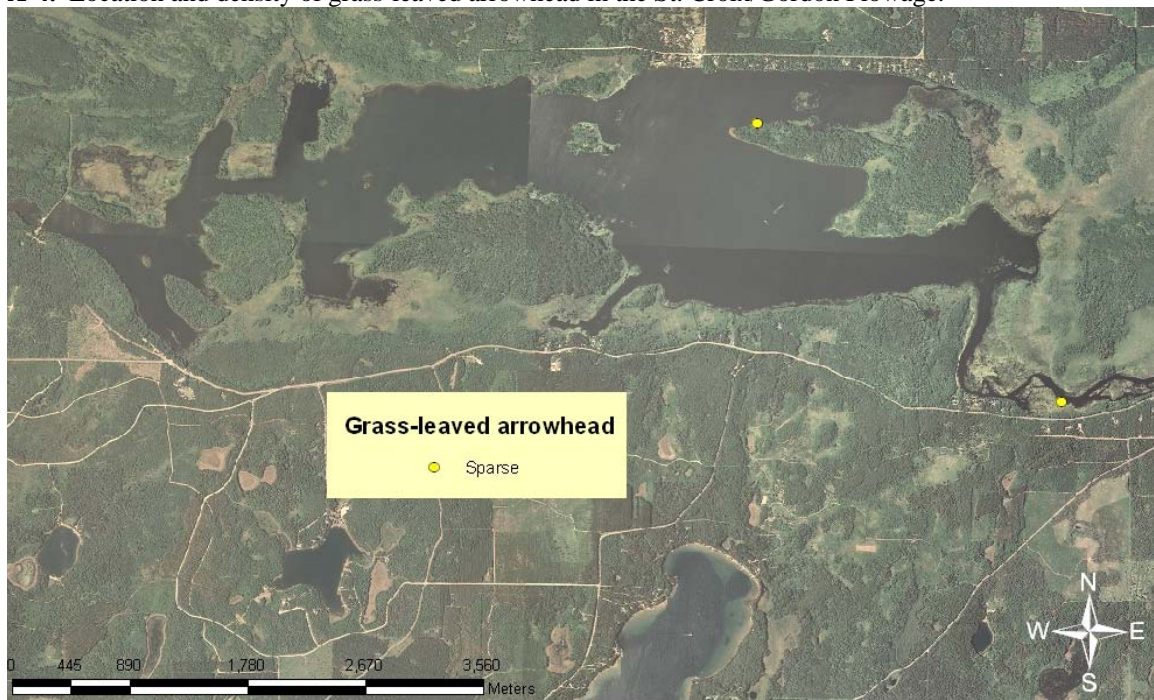
A-2. Location and density of floating leaved arrowhead in the St. Croix/Gordon Flowage.



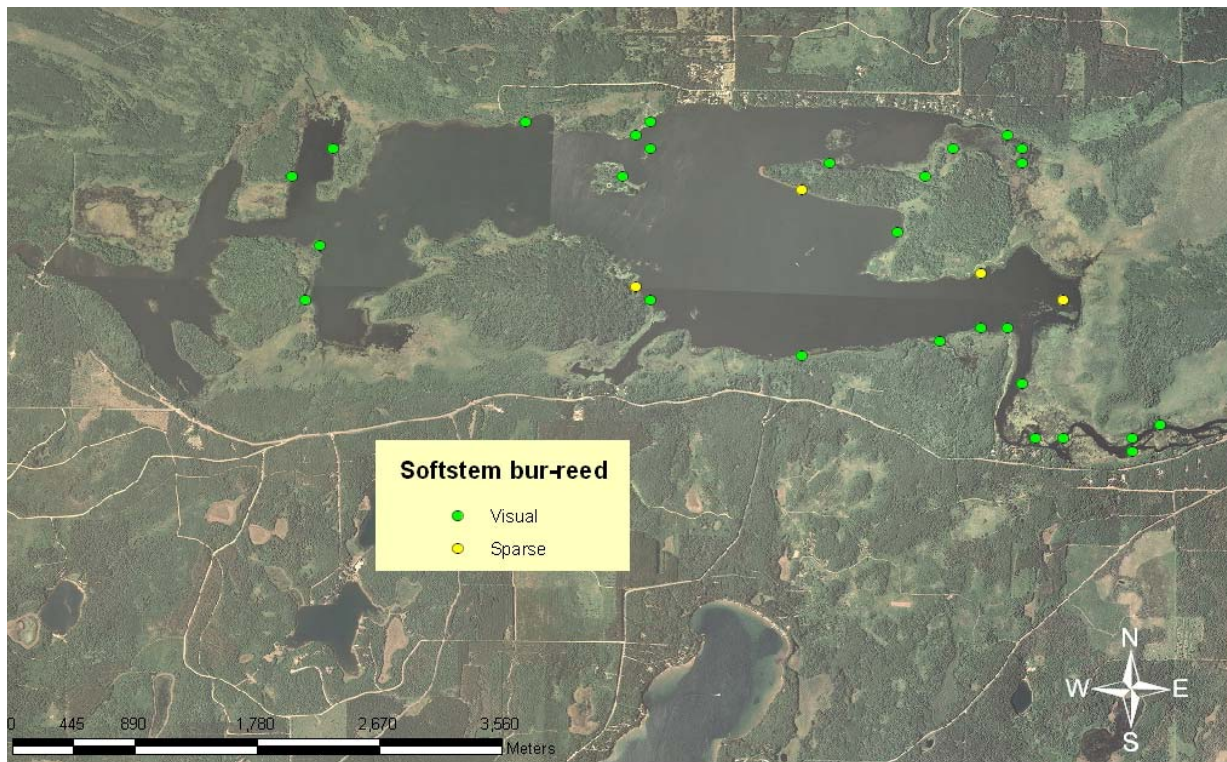
A-3. Location and density of spiny hornwort in the St. Croix/Gordon Flowage.



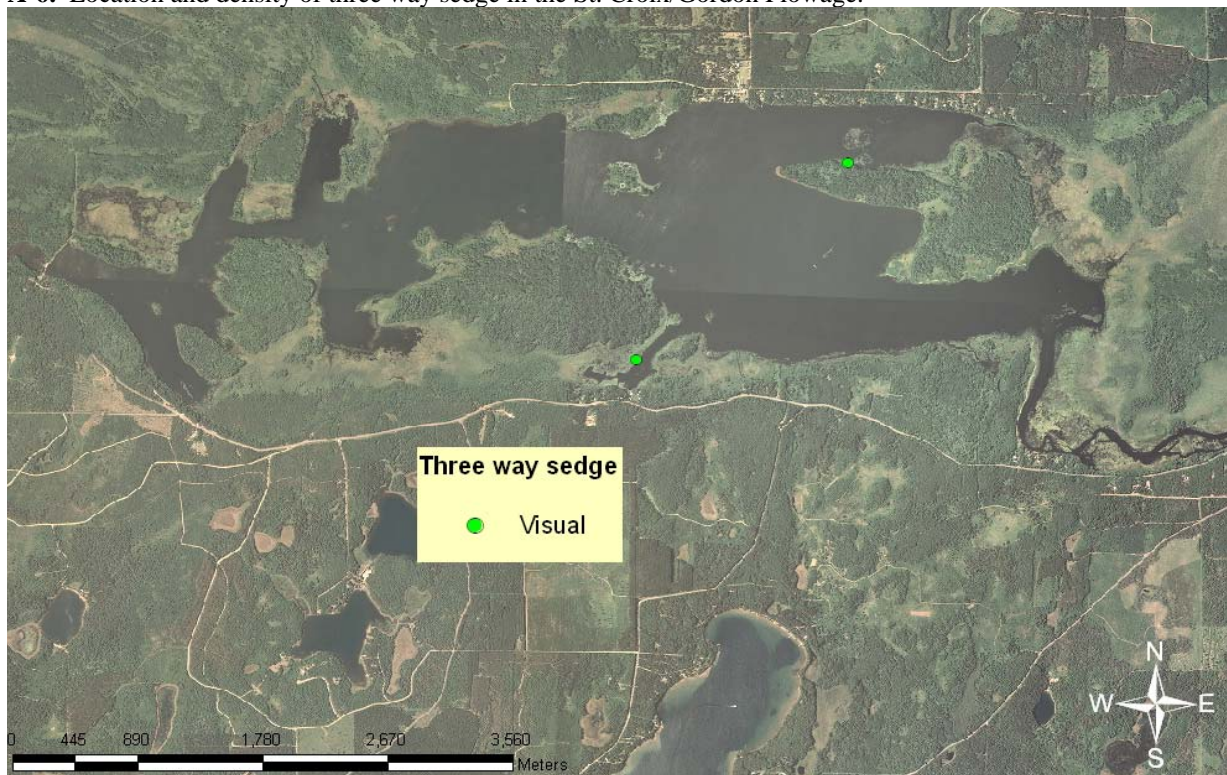
A-4. Location and density of grass-leaved arrowhead in the St. Croix/Gordon Flowage.



A-5. Location and density of softstem bur-reed in the St. Croix/Gordon Flowage.



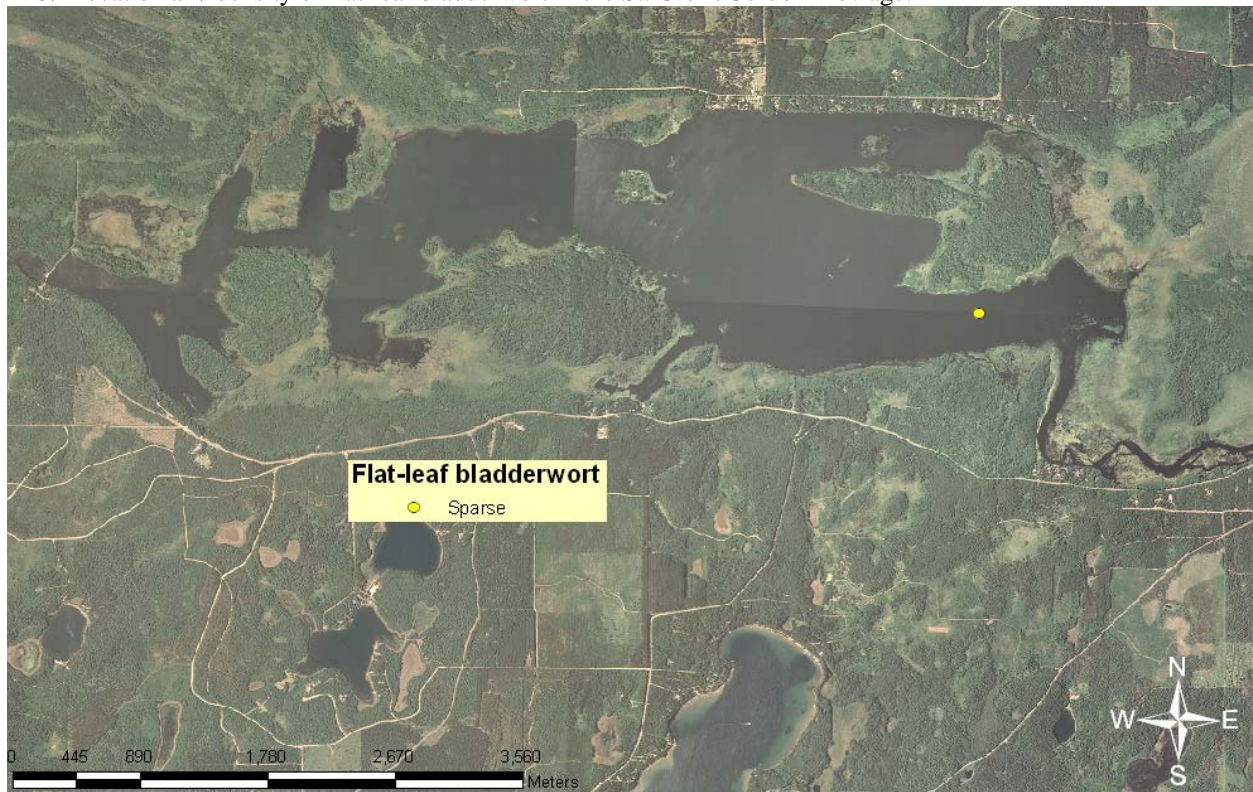
A-6. Location and density of three way sedge in the St. Croix/Gordon Flowage.



A-7. Location and density of wild calla in the St. Croix/Gordon Flowage.



A-8. Location and density of flat-leaf bladderwort in the St. Croix/Gordon Flowage.



A-9. Location and density of water bulrush in the St. Croix/Gordon Flowage.

